- Addition of the U.S. Fish and Wildlife Service Biological Opinion as an appendix to the Final EIS
- Addition of a Readers Guide to help readers understand the Final EIS

As stated in the Supplement to the Draft EIS, "The fundamental aspects of the repository have not changed." The differences in environmental impacts due to the changes noted above were minor. In most environmental resource areas, the impacts either stayed the same or were smaller than those presented in the Draft EIS or the Supplement to the Draft EIS. In those cases where the impacts were larger than previously presented (generally driven by the larger population used for analysis in the Final EIS), the increases were not materially larger.

S.5 Environmental Consequences of the Proposed Action

To analyze the potential environmental impacts associated with the Proposed Action, DOE compiled baseline information for various environmental resource areas and examined how the construction, operation and monitoring, and eventual closure of a repository at Yucca Mountain could affect each of those environmental resources, and resulting impacts on human health. In considering the impacts on human health, DOE analyzed both routine operations and accident scenarios.

ENVIRONMENTAL CONSEQUENCES

Under the regulations implementing the procedural provisions of the National Environmental Policy Act, an EIS should include a discussion of the *environmental consequences* of the Proposed Action and alternatives. The discussion of environmental consequences must include:

- Environmental *impacts* or *effects* (impacts are synonymous with effects under the regulations)
- Any adverse environmental impacts that cannot be avoided
- The relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity
- Any irreversible or irretrievable commitment of resources

Short-term consequences are those that could occur in the period before the completion of repository closure. DOE analyzed potential short-term impacts that could occur in resource areas as a result of performance confirmation, construction, operation and monitoring, closure, and transportation activities.

Long-term consequences are those that could occur after repository closure. DOE analyzed potential long-term impacts that could occur to human health and biological resources from radiological and chemical groundwater contamination for 10,000 years after repository closure. In addition, peak dose to 1 million years was estimated.

DOE conducted a broad range of studies to obtain or evaluate the information needed for the assessment of Yucca Mountain as a geologic repository. These studies have provided in-depth knowledge about the Yucca Mountain site and vicinity and provide sufficient information to aid in DOE decisionmaking. The Department used the information from these studies in the analyses described in this EIS. However, because some of these studies are ongoing, some of the information is incomplete. Further, the complexity and variability of the natural system at Yucca Mountain, the long period evaluated (10,000 years), and incomplete information or the unavailability of some information have resulted in uncertainty

in the analyses and findings. Throughout the EIS, DOE notes both the use of incomplete information if complete information is unavailable, and the existence of uncertainty, to enable the reader to better understand EIS findings.

The following paragraphs describe the potentially affected resources at the Yucca Mountain site and vicinity and a summary of the extent to which the Proposed Action could affect those resources.

S.5.1 YUCCA MOUNTAIN SITE AND VICINITY

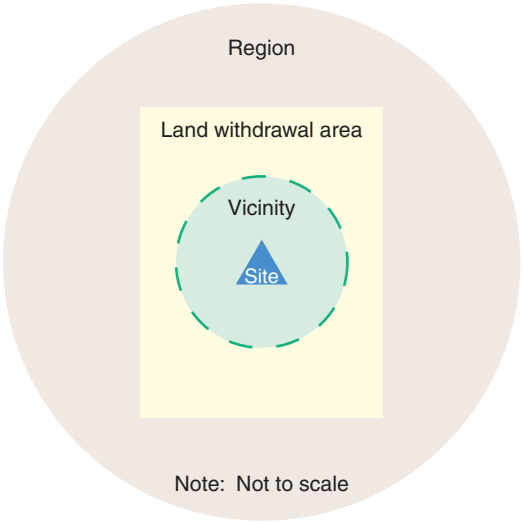
SITE-RELATED TERMS

Yucca Mountain site (the site): The area on which DOE has built or would build the majority of facilities or cause the majority of land disturbances related to the proposed repository.

Yucca Mountain vicinity: A general term used in nonspecific discussions about the area around the Yucca Mountain site. The EIS also uses terms such as area, proximity, etc., in a general context.

Land withdrawal area: An area of Federal property set aside for the exclusive use of a Federal agency. For the analyses in this EIS, DOE used an assumed land withdrawal area of 600 square kilometers, or 150,000 acres.

Region of influence (the region): A specialized term indicating a specific area of study for each of the resource areas that DOE assessed for the EIS analyses.



Controlled Area (as defined in 40 CFR Part 197) ***(not shown on illustration):*** The area surrounding the repository that is restricted to public access for the long term, as identified by passive institutional controls that DOE would install at closure. The controlled area could include as much as 300 square kilometers (about 120 square miles) surface and subsurface area. It would extend no more than 5 kilometers (3 miles) in any direction from the repository footprint except in the predominant direction of groundwater flow, where the controlled area would extend no farther south than 36 degrees, 40 minutes, 13.6661 seconds North latitude, the present latitude of the southwest corner of the Nevada Test Site [about 18 kilometers (11 miles)].

The Yucca Mountain site has several characteristics that would limit or restrict possible long-term impacts from the disposal of spent nuclear fuel and high-level radioactive waste. The site is isolated from concentrations of human population and human activity and is likely to remain so. The climate is arid and conducive to evapotranspiration (the loss of water by evaporation from the soil and other surfaces, including evaporation of moisture emitted or transpired from plants), resulting in a relatively small volume of water that can move through the mountain, contact waste materials, and move down to the water table. The groundwater table is at least 160 meters (530 feet) below the level at which DOE would emplace spent nuclear fuel and high-level radioactive waste, providing additional separation between water sources and emplaced materials. Groundwater from Yucca Mountain flows into a closed, sparsely populated hydrogeologic basin.

The Yucca Mountain site is on Federal land in a remote area of the Mojave Desert in Nye County in southern Nevada, about 160 kilometers (100 miles) northwest of Las Vegas, Nevada. The Yucca Mountain region is sparsely populated and receives only about 170 millimeters (7 inches) of precipitation each year. The Yucca Mountain Repository land withdrawal area would occupy about 600 square kilometers (230 square miles or 150,000 acres) of land currently under the control of DOE, the Department of Defense (U.S. Air Force), and the Department of the Interior (Bureau of Land Management).

Surface repository facilities would occupy as much as 6.0 square kilometers (2.3 square miles or 1,500 acres) of the Yucca Mountain site. The remainder of the site would be used to locate support facilities, and for continued performance confirmation and testing activities (for example, wells) and to separate repository facilities from other human activities. Performance confirmation and testing activities would take place on and in the vicinity of the site. The existing environment at the site includes the structures and physical disturbances from DOE-sponsored activities that took place from 1977 to 1988 related to the selection of Yucca Mountain for site characterization, and continuing site characterization activities that began in 1989 to determine the suitability of the site for a repository.

S.5.1.1 Land Use and Ownership

The Yucca Mountain site is in the southwest corner of the DOE Nevada Test Site, partially on and adjacent to the Nellis Air Force Range. The lands in the region include Bureau of Land Management special-use areas excluded from development that would require terrain alterations, unless the alterations would benefit wildlife or public recreation. The Fish and Wildlife Service of the U.S. Department of the Interior manages the Desert National Wildlife Range and the Ash Meadows National Wildlife Refuge, which are about 50 kilometers (30 miles) east and 39 kilometers (24 miles) south of Yucca Mountain, respectively. These areas provide habitat for a number of resident and migratory animal species in relatively undisturbed natural ecosystems. The National Park Service manages Death Valley National Park, which at its closest point is about 35 kilometers (22 miles) southwest of Yucca Mountain. The National Park Service also manages the small Devils Hole Protective Withdrawal in Nevada adjacent to the east-central boundary of Ash Meadows.

State-owned lands are limited in the vicinity of the proposed repository. There are scattered tracts of private land in and near communities such as Beatty and Indian Springs in Nevada. There are larger private tracts in the agricultural areas of the Las Vegas Valley, near

RUBY VALLEY TREATY ISSUE

The Western Shoshone people maintain that the Ruby Valley Treaty of 1863 gives them land rights to approximately one-third of the State of Nevada (including the Yucca Mountain region), along with portions of California, Utah, and Idaho. The Western Shoshone filed a claim in the early 1950s alleging that the Government had taken the tribe's land. The Indian Claims Commission found that Western Shoshone title to the land had gradually been extinguished, and set a monetary award as payment for the land. In 1976, the Commission entered its final award to the Western Shoshone people. The Western Shoshone dispute these findings, and have not accepted the monetary award for the lands in question. The tribe maintains that no payment has been made and that Yucca Mountain is on Western Shoshone land. Although DOE recognizes the sensitivity of this issue, a 1985 Supreme Court decision (United States v. Dann) held that the Western Shoshone claim to the land associated with the Ruby Valley Treaty has been extinguished, and that fair compensation has been made. The Supreme Court ruled that even though the monetary award has not been distributed, the United States has met its obligation and the aboriginal title to the land has been extinguished. DOE is aware that among the Native American community there is significant disagreement with the Court rulings.

Pahrump, and in the south-central portion of the large area that makes up the Amargosa Valley community. The closest year-round housing is at the location formerly known as Lathrop Wells, about 22 kilometers (14 miles) south of the site. This location is now part of the unincorporated Town of Amargosa Valley. There are farming operations about 30 kilometers (19 miles) south of the proposed repository. Figure S-17 shows the land use and ownership in the Yucca Mountain region.

Only Congress has the power to withdraw Federal lands permanently for the exclusive purposes of specific agencies. If the Yucca Mountain site was approved for development as a repository, a permanent land withdrawal would be necessary to isolate the land designated for the site from public access to satisfy Nuclear Regulatory Commission licensing requirements. The EIS analysis assumed the use of an area of approximately 600 square kilometers (150,000 acres) on Bureau of Land Management, U.S. Air Force, and DOE lands in the vicinity of the proposed repository. Figure S-18 shows the land withdrawal area that DOE used for analytical purposes. Proposed Action activities would require the use of as much as about 6.0 square kilometers (1,500 acres) of noncontiguous areas within the 600-square-kilometer (150,000-acre) area. These activities would not conflict with land uses on adjacent lands.

S.5.1.2 Air Quality

The evaluation of air quality impacts considered potential atmospheric releases of nonradiological pollutants and radiation doses from releases of radionuclides at the Yucca Mountain site. Nonradiological pollutant air concentrations were evaluated at the location of the maximally exposed individual member of the public and compared to National Ambient Air Quality Standards for criteria pollutants. Radiation doses were estimated for the maximally exposed individuals and populations of the public and workers.

Nonradiological Impacts. Principal nonradiological pollutants evaluated are the criteria pollutants nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter with a diameter less than 10 micrometers (PM_{10}). Emission of the gases nitrogen dioxide, sulfur dioxide, and carbon monoxide comes primarily from fuel combustion by vehicles, construction equipment, and boilers. PM_{10} is released mainly as a component of fugitive dust from land and excavation activities, as well as in smaller quantities from fuel combustion.

Exposures of the maximally exposed individual to airborne pollutants would be a small fraction of National Ambient Air Quality Standards. The highest concentrations of gaseous criteria pollutants (nitrogen dioxide, sulfur dioxide, and carbon monoxide) would be less than 1 percent of standards in all cases. Concentrations of PM_{10} were estimated to be relatively higher, less than 6 percent of the 24-hour limit and less than 2 percent of the annual limit during some project phases. These PM_{10} concentrations were estimated without considering common fugitive dust suppression measures, so actual concentrations would likely be lower.

The proposed site of the Yucca Mountain repository is in an area considered by the Environmental Protection Agency to be in attainment with Clean Air Act requirements. Therefore, Clean Air Act general conformity requirements do not apply to activities at the Yucca Mountain site.

Radiological Impacts. Radiological air quality impacts were evaluated as the radiation doses that could occur from airborne releases of radionuclides. The primary radionuclide released from Yucca Mountain would be naturally occurring radon-222 and its radioactive decay products. Releases of very small quantities of manmade radionuclides (krypton-85 and other noble gases) would occur only during the operations period, when spent nuclear fuel assemblies would be removed from transportation casks in the Waste Handling Building.

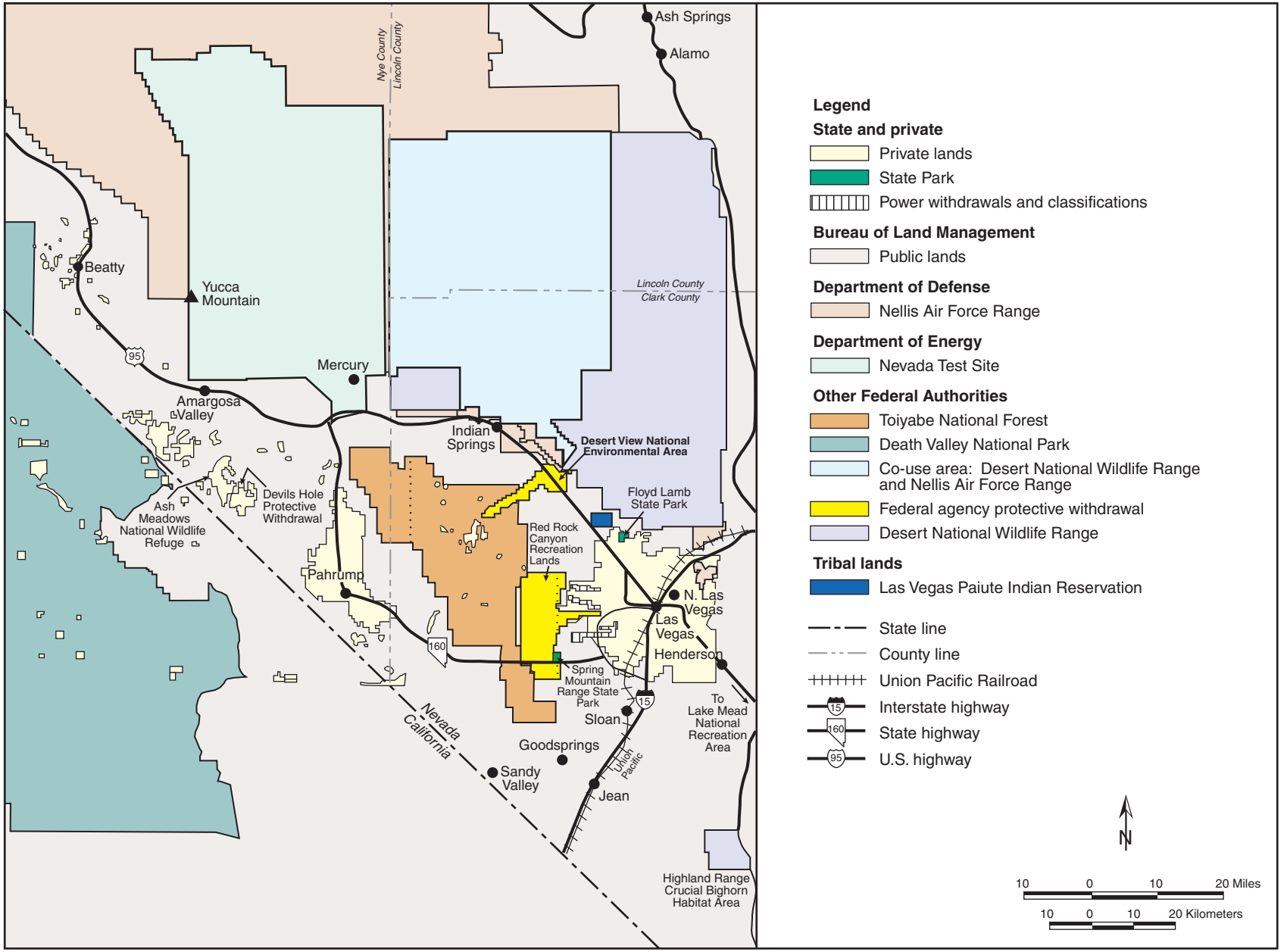


Figure S-17. Land use and ownership in the Yucca Mountain region.

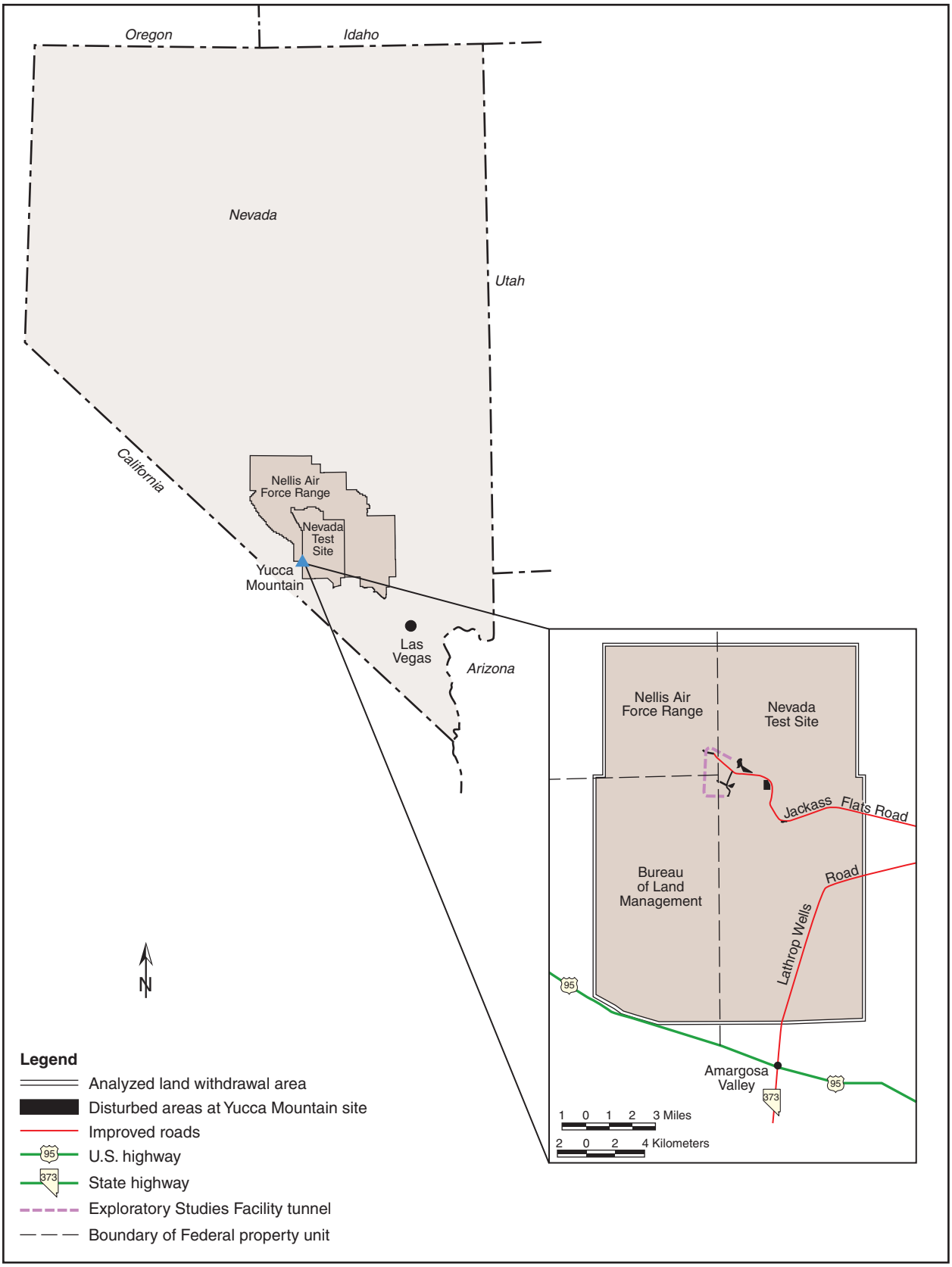


Figure S-18. Land withdrawal area used for analytical purposes.

RADIATION

In the United States, people are inevitably exposed to three sources of ionizing radiation: natural sources unaffected by human activities, such as cosmic radiation from space and natural radiation in the ground (for example, that from radon); sources of natural origin but affected by human activities, such as air travel and tunneling through rocks as at Yucca Mountain; and manmade sources, such as medical X-rays and consumer products. In the Yucca Mountain region, individuals are typically exposed to a 340- to 390-millirem radiation dose from natural and manmade sources each year, compared to about 300 millirem for the average person living in other areas of the United States.

When a person is exposed to ionizing radiation, the amount absorbed by the body is called the radiation *dose*. Dose is often described in measurement units of *rem*, which take into account how different types of radiation affect the body (the biological effectiveness). Small doses are described in *millirem*, each of which is one one-thousandth of a rem.

To analyze the short-term impact of exposure to radiation, DOE used a *maximally exposed individual* (member of the public, involved worker, or noninvolved worker), defined as the individual whose location and habits result in the highest potential total radiation dose from a particular source for all exposure routes (inhalation, ingestion, direct exposure). For long-term impacts, DOE used a *reasonably maximally exposed individual* (member of the public), defined as a hypothetical individual whose location and habits would place this individual among those with the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (for example, inhalation, ingestion, direct exposure).

The maximum annual dose to the maximally exposed individual member of the public would range from about 0.73 millirem per year to 1.3 millirem per year, depending on the operating mode. The range in dose is due primarily to the varying size of the repository, with a larger repository having higher radon release and resulting in higher dose. Greater than 99.99 percent of the annual dose would be from radon-222 and radon decay products. The preclosure Public Health and Environmental Standard found at 10 CFR 63.204 is 15 millirem per year to a member of the public. Maximum annual doses from repository activities would range from about 5 to 9 percent of this standard. The average individual in the United States receives 200 millirem per year from exposure to naturally occurring radon and its decay products, so Yucca Mountain releases would be expected to add less than 0.7 percent to the natural background dose from radon.

Radiation doses from radionuclides released to air were also estimated for the general population within 80 kilometers (50 miles) of the site, the maximally exposed noninvolved worker, and the noninvolved worker population at Yucca Mountain. There are no applicable air quality standards for these exposure groups and individuals. However, these radiation doses are used to estimate the potential human health impacts presented in Section S.4.1.7. Estimates of health impacts to members of the public are converted directly from these air quality dose estimates. The doses to noninvolved workers from airborne exposures would be very small compared to other occupational doses; therefore, the doses estimated here would contribute minimally to the estimates of health impacts to noninvolved workers presented in Section S.4.1.8.

S.5.1.3 Geology

Yucca Mountain originated from volcanism and faulting that occurred 14 million to 11.5 million years ago. The mountain is bordered on the north by Pinnacles Ridge and Beatty Wash, on the west by Crater Flat, on the south by the Amargosa Desert, and on the east by the Calico Hills and by Jackass Flats, which

contains Fortymile Wash. Beatty Wash is one of the largest tributaries of the Amargosa River and drains the region north and west of Pinnacles Ridge, a part of Yucca Mountain that is north of the proposed repository. Fortymile Wash is the most prominent drainage through Jackass Flats to the Amargosa River. The river is dry along most of its length most of the time. Figure S-19 shows the physiographic subdivisions and characteristic land forms in the region of influence for geology.

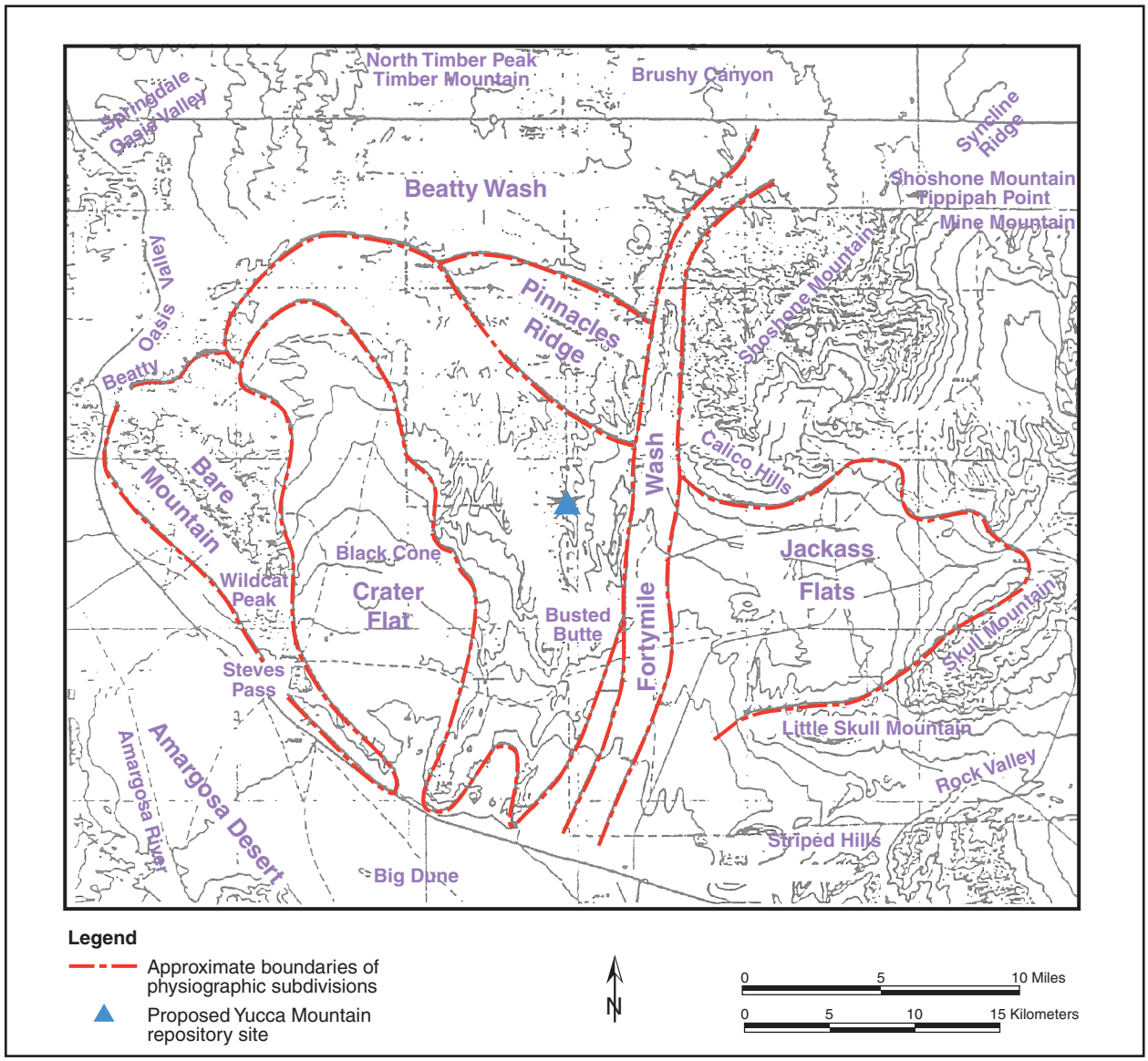


Figure S-19. Physiographic subdivisions of the Yucca Mountain area.

DOE would build the proposed repository and emplace the waste packages in a mass of volcanic rock (welded tuff) known as the Topopah Spring Tuff. This formation was formed by a volcanic ash-flow from the calderas north of Yucca Mountain 12.8 million years ago and has not been disturbed by volcanic activity since then. The volcanic activity that produced these rocks is complete and, based on the geology of similar volcanic systems in the region, additional silicic volcanic activity would be unlikely. (Younger, small-volume basaltic volcanoes to the south, west, and northwest of Yucca Mountain have been the focus of extensive study by DOE.) DOE chose the Topopah Spring Tuff as the potential repository emplacement area because of (1) its depth below the ground surface that would protect nuclear materials

VOLCANISM

Differing views on the risks of volcanism near Yucca Mountain result from uncertainty in the volcanic hazard assessment. To address these uncertainties, DOE has conducted extensive volcanic hazard assessments, considered alternative interpretations of the geologic data, and consulted with recognized experts. In 1995 and 1996, DOE convened a panel of recognized experts representing other Federal agencies (for example, the U.S. Geological Survey and national laboratories) and universities (for example, the University of Nevada and Stanford University) to assess uncertainties associated with the data and models used to evaluate the potential for disruption of the proposed Yucca Mountain Repository by a volcanic intrusion. The panel estimated that the chance of a volcanic disruption at or near the repository during the first 10,000 years after closure would be 1 in 7,000.

from exposure to the environment, (2) its extent and characteristics that would enable the construction of stable openings and the accommodation of a range of temperatures, (3) its location away from major faults that could adversely affect the stability of underground openings and could provide pathways for water flow, eventually leading to radionuclide release, and (4) its location well above the present water table.

North-trending seismic faults are the characteristic geological structural elements at Yucca Mountain. The Solitario Canyon Fault along the west side of Yucca Mountain and the Bow Ridge Fault along the east side are the major block-bounding faults that bracket the area under consideration for the proposed repository. The proposed repository has been configured such that there would be no block-bounding faults in the emplacement zone. Between the major north-trending, block-bounding faults there are intrablock or subsidiary faults. One intrablock fault, called the Ghost Dance Fault, is in the area of the proposed repository and one relatively short, northwest-trending subsidiary fault, the Sundance Fault, transects the area of the proposed repository. Studies at Yucca Mountain indicate that individual faults have very long recurrence intervals between the types of earthquakes that would be powerful enough to cause surface displacements. Strain can accumulate on these faults over long periods between surface-rupturing earthquakes. Little or no seismic activity might occur during this long strain buildup.

EARTHQUAKES

Experts have evaluated site data and other relevant information to assess where and how often future earthquakes could occur, how large they could be, how much offset could occur at the Earth's surface, and how much ground motion could diminish with distance. DOE would design the repository to withstand the effects of earthquakes that might reasonably occur in the future.

DOE has monitored seismic activity at the Nevada Test Site since 1978. In 1992, an earthquake measuring 5.6 on the Richter scale occurred at Little Skull Mountain, about 20 kilometers (12 miles) southeast of Yucca Mountain. It caused no detectable damage in tunnels or characterization facilities at the Yucca Mountain site, but did cause some minor damage at the Field Office Center in Jackass Flats about 5 kilometers (3 miles) north of the epicenter.

S.5.1.4 Hydrology

Yucca Mountain is in the Alkali Flat-Furnace Creek groundwater basin, which is within the larger Death Valley Regional Groundwater Flow System). This area is characterized by a very dry climate, limited surface water, and generally deep aquifers. The Death Valley basin is a closed hydrologic basin, which means its surface water and groundwater can leave only by evaporation from the soil and other surfaces and transpiration from plants. Surface-water resources include drainages and streambeds, streams,

springs, and playa lakes. The groundwater system includes recharge zones (where water infiltrates from the surface and reaches the saturated zone and aquifers), discharge points (where groundwater reaches the surface), unsaturated zones (above the water table), saturated zones (below the water table), and aquifers (water-bearing layers of rock that can provide water in usable quantities).

Surface Water. Yucca Mountain and the Death Valley Basin, like other areas in the southern Great Basin, generally lack perennial streams and other surface-water bodies. The Amargosa River system drains Yucca Mountain and the surrounding areas. Although referred to as a river, the Amargosa and its tributaries (the washes that drain to it) are dry along most of their lengths most of the time.

Activities associated with the Proposed Action could cause minor impacts to surface hydrology at the Yucca Mountain site. The potential for contaminants to reach surface water generally would be limited to spills or leaks followed by a rare precipitation or snow melt event large enough to generate runoff. The most likely sources of potential surface-water contaminants would be the fuels (diesel and gasoline) and lubricants (oils and greases) needed for equipment. Because these materials would be used and stored inside buildings or appropriate containment structures and managed in accordance with standard best management practices, there would be little potential for contamination to spread to surface water.

Disturbing the land surface probably would alter the rate at which water could infiltrate the surface. Of the approximately 4.3 to 6.0 square kilometers (1.7 to 2.3 square miles or 1,060 to 1,500 acres) needed for surface repository facilities, construction and operation and monitoring activities probably would disturb about 2.8 to 4.5 square kilometers (690 to 1,100 acres). The amount of newly disturbed land would vary depending on the operating mode used. The high end of the range would be attributed to the lower-temperature operating mode with maximum waste package spacing and surface aging. However, DOE expects the resulting change in the amount of runoff actually reaching the drainage channels to be relatively minor because repository activities would disturb a relatively small amount of the natural drainage area. The eventual removal of structures and impermeable surfaces, with mitigation (soil reclamation) and rehabilitation of natural plants in disturbed areas, would decrease runoff from these areas.

Facilities at which DOE would manage radioactive materials would be able to withstand the probable maximum flood (the most severe flood that is reasonably foreseeable). The foundations would be built up as necessary so the facilities would be above the flood level. Other facilities would be designed and built to withstand a 100-year flood, consistent with common industrial practice. The water levels expected from a 100-year, 500-year, or probable maximum flood would be unlikely to reach the North or South Portal entrances to the subsurface facilities, but some of the support facilities outside the North Portal would be within the level of the probable maximum flood. Access routes to the North Portal Operations Area and the South Portal Development Area would cross the lower magnitude flood areas as well.

Portions of the transportation system probably would be in the 100-year floodplains of Midway Valley Wash, Drillhole Wash, Busted Butte Wash, and/or Fortymile Wash. Structures that might be constructed in a floodplain could include one or more bridges to span the washes, one or more roads that could pass through the washes, or a combination of roads and culverts in the washes. Based on an initial assessment, potential impacts from such activities would be minor.

Groundwater. The groundwater flow system of the Death Valley region is very complex, involving many groundwater basins, as shown in Figure S-20. Over distance, aquifers and confining units in the groundwater flow system vary in their characteristics or even their presence. In some areas, confining units allow considerable movement between aquifers; in other areas confining units are sufficiently tight to support artesian conditions (where water in a lower aquifer is under pressure in relation to water in an overlying aquifer).

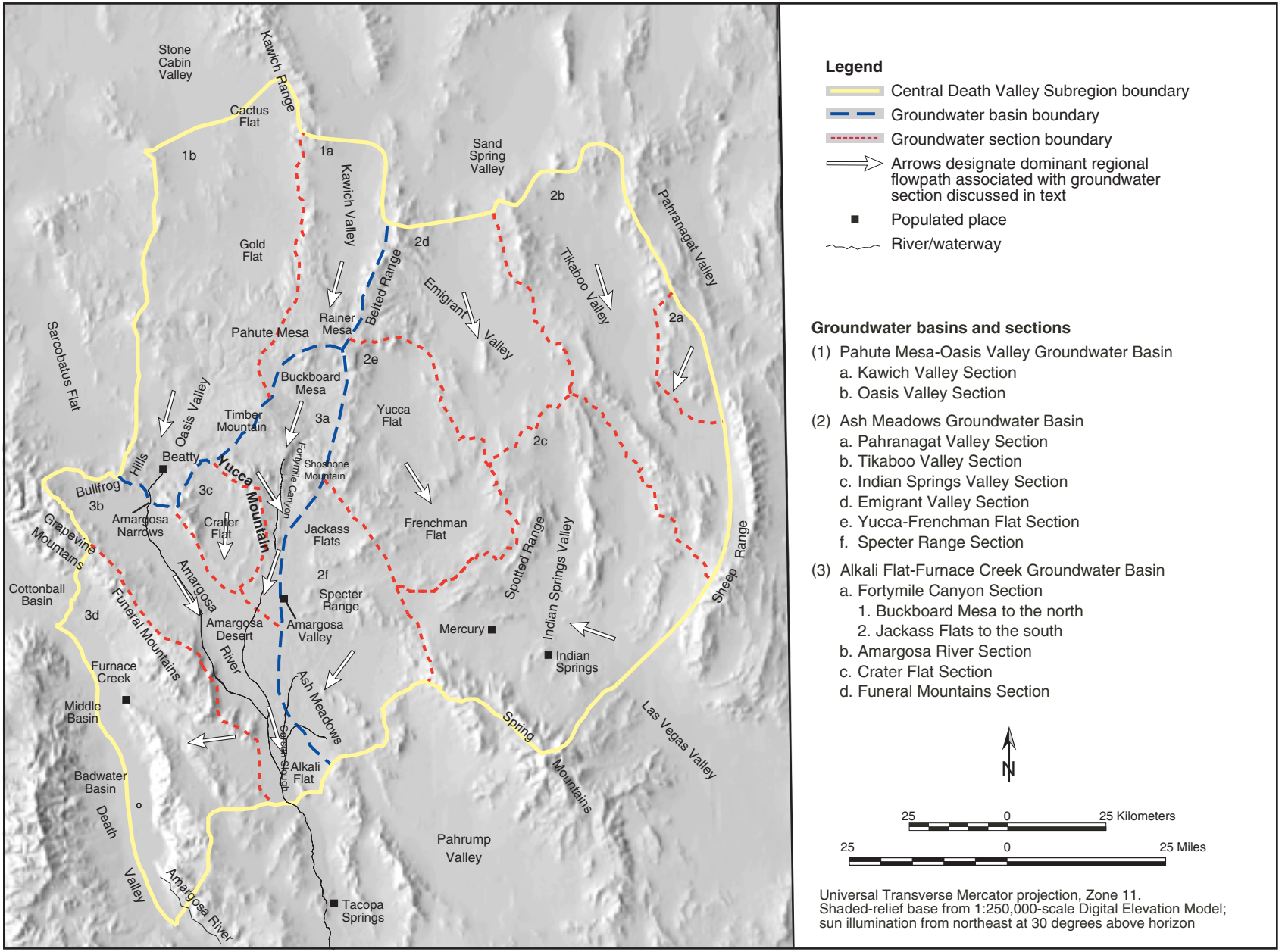


Figure S-20. Groundwater basins in the Yucca Mountain vicinity.

Groundwater in aquifers below Yucca Mountain and in the surrounding region flows generally south toward discharge areas in the Amargosa Desert and Death Valley. This broad area is called the Death Valley regional groundwater flow system. The area around Yucca Mountain is in the central subregion of the Death Valley regional groundwater flow system, which has three groundwater basins: (1) Pahute Mesa-Oasis Valley, (2) Ash Meadows, and (3) Alkali Flat-Furnace Creek.

GROUNDWATER

Aquifer: A subsurface saturated rock unit of sufficient permeability to transmit groundwater and capable of yielding usable quantities of water to wells and springs.

Confining unit: A rock or sediment layer that restricts the movement of water into or out of adjacent aquifers.

Spring: A point (sometimes a small area) through which groundwater emerges from an aquifer to the ground surface.

There is scientific uncertainty about the exact locations of the groundwater flow boundaries between the three groundwater basins in the central Death Valley subregion. All interpretations of the available data, however, place the aquifers below Yucca Mountain in the central Alkali Flat-Furnace Creek groundwater basin. In the region of influence for hydrology, the primary sources of groundwater recharge are infiltration on Pahute Mesa, Rainier Mesa, Timber Mountain, and Shoshone Mountain to the north, and the Grapevine and Funeral Mountains to the south. Recharge in the immediate Yucca Mountain vicinity is small in comparison and consists of water reaching Fortymile Wash as well as precipitation that infiltrates the surface. DOE studies indicate that the quantity of water that might move through a repository area of 10 square kilometers (2,500 acres), assuming 4.7 millimeters (0.2 inch) of infiltration per year, would be about 0.2 percent of the estimated 23.4 million cubic meters (19,000 acre-feet) that moves from the Amargosa Desert to Death Valley on an annual basis.

To pose a threat to groundwater during the construction, operation and monitoring, or closure phase of the Proposed Action, a contaminant such as a hazardous material would have to be spilled or released and then carried down either by its own weight or by infiltrating water. The depth to groundwater [at least 160 meters (530 feet)] and the arid environment would combine to reduce the potential for contaminant migration during the preclosure period of repository operations.

The most likely way to affect infiltration rates and, thus, groundwater recharge would be as the result of a land disturbance that caused additional runoff from the facilities to accumulate in areas like Fortymile Wash. That is, the additional runoff could increase groundwater recharge. However, given the dry climate and relatively small amount of potentially disturbed area in relation to the surrounding unchanged areas, the net change in infiltration would be small. After closure, the implementation of soil reclamation and revegetation would accelerate a return to more natural infiltration conditions.

DOE would meet the water demand for the Proposed Action by pumping from the groundwater in the Jackass Flats area. Estimates of perennial yield of the aquifer (the quantity of groundwater that can be withdrawn annually without depleting the reservoir, also referred to as safe yield) in the Jackass Flats area ranges from 1.1 million to 4.9 million cubic meters (880 to 4,000 acre-feet). The highest demand during the repository construction phase and the operation and monitoring phase [as high as 360,000 cubic meters (290 acre-feet) per year], added to the demand from ongoing Nevada Test Site activities, would be below the lowest estimate of the area's perennial yield.

Maximum repository water demands would occur during emplacement and development activities and, when combined with the baseline demands from Nevada Test Site activities, would approach (but still be below) the lowest perennial yield estimate. None of the water demand estimates would approach the high estimates of perennial yield.

S.5.1.5 Biological Resources and Soils

The plants and animals in the Yucca Mountain vicinity are typical of species in the Mojave and Great Basin Deserts. No plants listed as *threatened* or *endangered*, that are proposed for listing, or that are candidate species under the Endangered Species Act occur in the land withdrawal area analyzed in this EIS. No plant species classified as *sensitive* by the Bureau of Land Management are known to occur in the analyzed land withdrawal area. Several species of cacti and yucca protected from commercial collection by the State of Nevada occur throughout the Yucca Mountain region, including the analyzed land withdrawal area. Neither the removal of vegetation from the area required for the repository nor the impacts to some species would affect regional biological diversity and ecosystem function. Repository construction activities in areas of undisturbed vegetation could result in additional areas where colonization by exotic (non-native) plant species could occur. Reclamation would enhance the recovery of native vegetation in disturbed areas and reduce colonization by exotic species.

One animal species that lives at the Yucca Mountain site, the desert tortoise, is listed as *threatened* under the Endangered Species Act. Yucca Mountain is at the northern edge of the range of the desert tortoise, and the presence of tortoises at the site is infrequent in comparison to other portions of its range. DOE anticipates that the deaths of small numbers of individual tortoises from vehicle traffic and activities could occur during the repository construction, operation and monitoring, and closure phases. Although these losses would cause a small decrease in the abundance of desert tortoises in the immediate vicinity of the repository site, they would not affect long-term survival of the local or regional population of the species. DOE would continue to work with the Fish and Wildlife Service and would implement the terms and conditions established by the Service in its Biological Opinion to minimize impacts to desert tortoises at the site. There is no critical habitat in the analyzed land withdrawal area.

Five animal species classified as *sensitive* by the Bureau of Land Management (two bats, a lizard, an owl, and a beetle) occur at the Yucca Mountain site. These species are unlikely to be affected by repository activities because loss of individuals would be rare or a small amount of habitat would be disturbed, depending on the species.

There would be small quantities of routine releases of radioactive materials from the repository during the preclosure period. These releases would consist of gases, principally naturally occurring radon, and krypton from spent nuclear fuel handling. The small quantities released would result in small doses to plants and animals as the gases dispersed in the atmosphere. The estimated doses would be unlikely to cause measurable detrimental effects in populations of even the more radiosensitive species in terrestrial ecosystems.

There are no naturally occurring wetlands on the proposed repository site, so no impacts to such areas would occur as a result of repository construction, operation and monitoring, or closure. Soils at the site are from underlying volcanic rocks and mixed alluvium (sand, silt, or clay deposited on land by water) dominated by volcanic material, and in general have low water-holding capabilities. The potential for soil impacts such as erosion would increase slightly as a result of land-disturbing activities at the site, but DOE would use erosion control techniques to minimize impacts.

DOE also considered whether, during the postclosure period, the repository would affect biological resources at Yucca Mountain on the repository footprint through the heating of the ground surface and through radiation exposure to species from contaminant migration through groundwater to discharge points. After closure under the higher-temperature operating mode, heat from the decay of radionuclides in the waste would cause temperatures in the rock near the disposal containers to rise above the boiling point of water. The time that the subsurface temperature could remain above the boiling point would vary

up to a few thousand years. Conduction and the flow of heated air and water through the rock would carry the heat away from the waste packages through the rock. The heat would spread to the surface above and to the aquifer below.

Although the atmosphere would remove excess heat when it reached the ground surface, the temperature of near-surface soils could increase slightly. As reported in the Draft EIS for the hotter, high thermal load scenario, surface soil temperatures were estimated to increase by as much as approximately 3°C (5.4°F) in dry soil at a depth of 1 meter (3.3 feet), which could affect root growth and the growth of microbes or nutrient availability. The range of repository operating modes now being considered would provide a cooler repository than the high thermal load analyzed in the Draft EIS, so any soil temperature increases would be less than those cited above. Potential impacts from the repository on biological resources could consist of an increase of heat-tolerant species and a decrease of less heat-tolerant species. In general, areas affected by repository heating could experience a loss of shrub species and an increase in annual species. A shift in the plant community could also lead to localized changes in the animal community that depends on the plant community for food and shelter. The effects of repository heat on the surface soil temperatures would gradually decline with distance from the repository out to about 500 meters (1,640 feet). DOE expects any shift in species composition to be limited to that general area.

In the distant future (many thousands of years) groundwater would contain small quantities of radionuclides and chemically toxic substances. Doses to humans from exposure to this water would be very small; doses to plants and animals would be even smaller, and unlikely to have adverse impacts on the population of any species.

Impacts to surface soils at Yucca Mountain in the postclosure period would be possible. If vegetation cover decreased as a result of the presence of the repository, the amount of rainfall runoff and the amount of erosion and subsequent sedimentation could be higher. In rare cases of significant runoff, this could change the quality of surface water in the Yucca Mountain area.

S.5.1.6 Cultural Resources

Land disturbances associated with the Proposed Action could have direct impacts on cultural resources around Yucca Mountain. Archaeological investigations in the immediate vicinity of the proposed surface facilities during characterization studies and infrastructure construction combined with other cultural resource investigations in the area have identified 830 archaeological and historic sites in the analyzed land withdrawal area. Most of the archaeological sites are small scatters of stone artifacts. None of the sites has been listed on the *National Register of Historic Places,* but 150 are potentially eligible.

Repository development would disturb no more than about 4.5 square kilometers (1,100 acres) of previously undisturbed land at the site. Before repository development activities began, DOE would identify and evaluate archaeological or cultural resources sites for their importance and eligibility for inclusion on the *National Register of Historic Places*. DOE would avoid such sites if possible or, if avoidance were not possible, DOE would conduct a data recovery program in cooperation with tribal representatives and other appropriate officials and would document the findings. Artifacts and knowledge from the site would be preserved. Improved access to the area could lead to indirect impacts, which could include unauthorized excavation or collection of artifacts. Training, which is ongoing during site characterization activities, would continue to be provided to workers on the laws and regulations related to the protection of cultural resources.

Studies have described several Native American sites, areas, and resources in or immediately adjacent to the analyzed land withdrawal area. DOE recognizes that Native Americans have concerns about protecting traditions and the spiritual integrity of the land in the Yucca Mountain region, and that these concerns extend to the propriety of the Proposed Action. The Consolidated Group of Tribes and

Organizations in the area surrounding the Yucca Mountain site value the cultural resources in the area, viewing them in a holistic manner. They believe that the water, animals, plants, air, geology, sacred sites, and artifacts are interrelated and dependent on each other for existence. Because of the general level of importance attributed to the land by these Native Americans, and because they regard the land as part of an equally important integrated cultural landscape, these Native Americans consider the intrusive nature of the repository to be an adverse impact to all elements of the natural and physical environment. The establishment of the land withdrawal boundary and construction of the repository would continue to restrict their free access to these areas. Figure S-21 shows traditional boundaries and locations of tribes in the region.

S.5.1.7 Socioeconomics

Southern Nevada has been one of the fastest-growing areas in the country, with its economy being driven by the growth of the hotel and gaming industry. Most of the Yucca Mountain Project and Nevada Test Site onsite employees live in Clark (93 percent of employees) and Nye (4 percent) Counties. Between 1990 and 2000, the population in the region of influence (Clark, Lincoln, and Nye Counties), led by Clark County, grew by 88 percent, compared to 66.3-percent population growth in Nevada and 13.1-percent population growth in the United States as a whole. Clark County reached a population of about 1.4 million in 2000 and added an average of more than 38,000 new jobs a year during the 1990s. Similarly, Nye County experienced an 83-percent growth rate for the decade, while Lincoln County's population increased by about 10 percent between 1990 and 2000. Although new jobs have been added to the region's economy each month, some potential employees lack necessary job skills. As a result, Clark County has maintained an unemployment rate that remains near State and national averages. In 2000, Nye and Lincoln Counties had unemployment rates above the State and national averages. In addition, the residential housing market is strong and steady; steady employment and population growth are spurring the demand for housing. Public services such as education, health care, law enforcement, and fire protection are adequate. However, these services likely will require expansion if the general growth in the economy and population continues.

The DOE evaluation of impacts to the socioeconomic environment in communities in the vicinity of the proposed repository considered changes to employment, population, economic measures, housing, and public services. For all five socioeconomic parameters evaluated, the impacts would be very small, less than 1 percent of the baselines for the region. For example, the largest change in population would range from less than 1 percent in Clark County and Nye County, to as high as 2.4 percent in Lincoln County (assuming the selection of a rail or heavy-haul transportation route in Lincoln County).

The lower-temperature repository operating mode with surface aging would have the highest potential socioeconomic impact due to the longer operation period. This scenario would result in a maximum of 0.3-percent increase in direct and indirect employment in the peak construction year (2006). Population increases caused by the increased employment opportunities would peak in 2030 at about 5,700, or less than 0.25 percent of the baseline for that year.

In light of public comments received on the Draft EIS concerning perceived risk and stigmatization, DOE reexamined relevant studies and literature to determine whether the state of the science in predicting future behavior based on perceptions had advanced sufficiently to allow DOE to quantify the impacts of public risk perception on economic development or property values in potentially affected communities. The following conclusions were reached from evaluation of these literature reviews plus scientific and social studies carried out in the past few years:

- While in some instances risk perceptions could result in adverse impacts on portions of a local economy, there are no reliable quantitative methods whereby such impacts could be predicted with any degree of certainty.

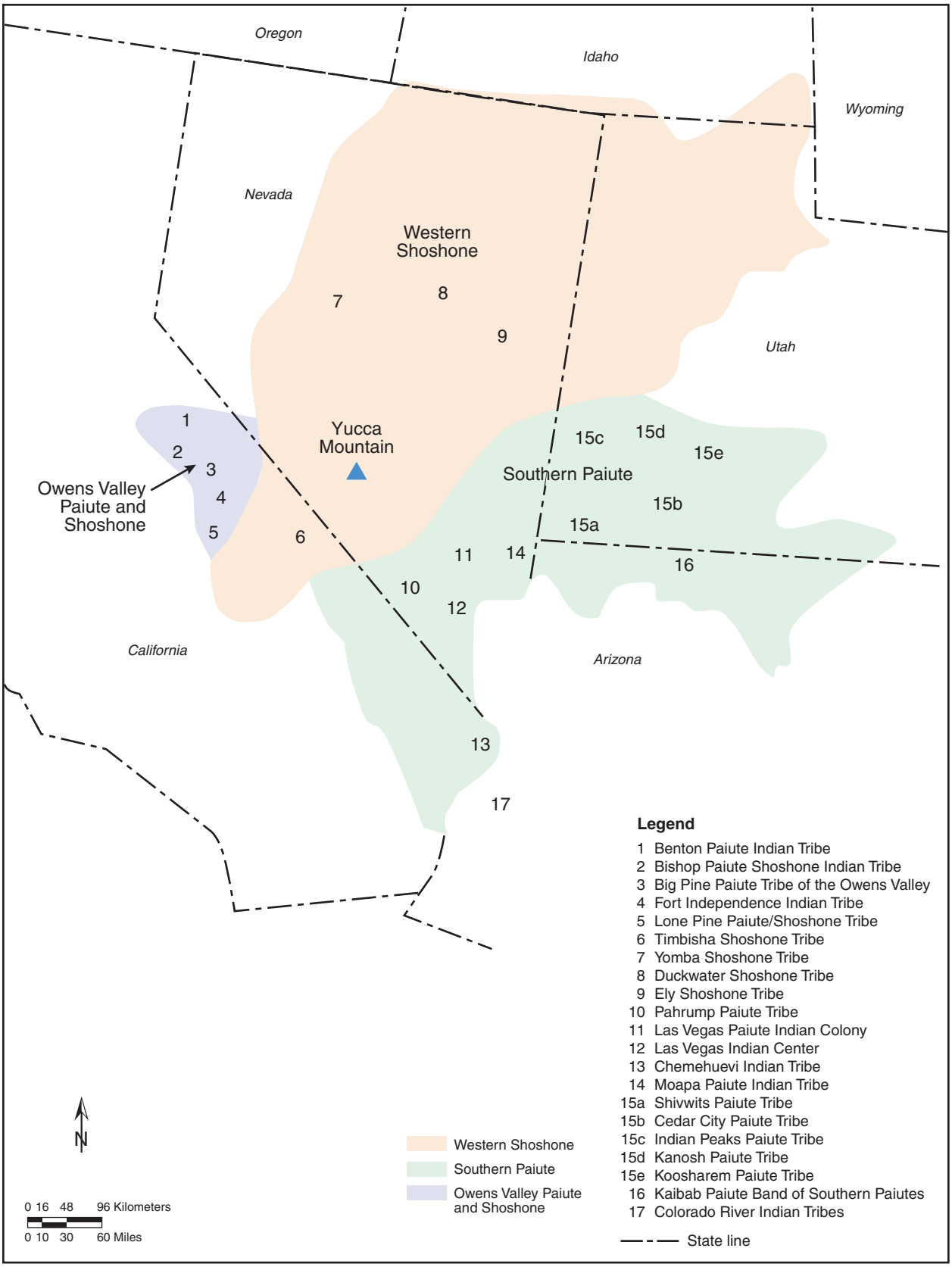


Figure S-21. Traditional boundaries and locations of tribes in the Yucca Mountain region.

- Much of the uncertainty is irreducible, and
- Based on a qualitative analysis, adverse impacts from perceptions of risk would be unlikely or relatively small.

S.5.1.8 Occupational and Public Health and Safety

The analysis of occupational and public health and safety considered short-term (prior to closure) health impacts from routine operations (1) to workers from hazards that are common to similar industrial settings and excavation operations, such as falling or tripping (referred to as industrial hazards), (2) to workers and the public from naturally occurring nonradiological materials in the rock under Yucca Mountain, (3) to workers as a result of radiation exposure during their work activities, and (4) to the public from airborne releases of radionuclides (estimated doses are described in Section S.4.1.2). The analysis separately considered involved workers (those who would participate in a particular activity) and noninvolved workers (those who would be on the site but would not participate directly in the activity in question).

Impacts to Workers from Industrial Hazards. Workers would be subject to industrial hazards during all phases of the Proposed Action. Examples of the types of industrial hazards that could present themselves include tripping, being cut on equipment or material, dropping heavy objects, and catching clothing in moving machine parts. Most impacts would be the result of fuel handling in the Waste Handling Building during the operations period. The next biggest component of industrial hazards would be the result of the subsurface excavation.

The estimated number of workplace fatalities from industrial hazards over the project life would range from 2.0 for the higher-temperature repository operating mode to between 2.2 and 3.3 for the lower-temperature operating mode.

Nonradiological Impacts to Workers and the Public. DOE would use engineering controls during subsurface work to control exposures of subsurface workers to dust that might contain cristobalite, a form of crystalline silica. If engineering controls could not keep dust concentrations below established limits, administrative controls such as respiratory protection would be used until engineered controls could reduce concentrations. Similar controls would be applied for surface workers if necessary. DOE expects that exposure of subsurface and surface workers to cristobalite would be well below applicable regulatory limits and that potential impacts to these workers would be low. Cristobalite concentrations at the site boundary would be small and unlikely to pose impacts to the public.

HEALTH AND SAFETY IMPACTS (AFFECTED INDIVIDUALS)

Workers
- Industrial hazards
  - Involved workers
  - Noninvolved workers
- Nonradiological impacts
  - Involved workers
  - Noninvolved workers
- Radiological impacts
  - Involved workers
  - Noninvolved workers

Public
- Nonradiological impacts
  - Maximally exposed individual
  - Population
- Radiological impacts
  - Maximally exposed individual
  - Population

Radiological Impacts to Workers. Radiological impacts to workers are reported both in terms of the increase in likelihood of a latent cancer fatality for an individual, and the increase in the total number of latent cancer fatalities for the total worker population. The probability of the maximally exposed worker incurring a latent cancer fatality from repository-related radiation exposure would range from about 0.0072 to 0.012 (7 to 12 chances in 1,000) for a 50-year working lifetime. The total estimated number of

LATENT CANCER FATALITIES

As used in this EIS, a latent cancer fatality is a death resulting from cancer that has been caused by exposure to ionizing radiation. There is typically a latent period between the time of radiation exposure and the time the cancer cells become active. Exposure to radiation that results in a 1-rem (1,000-millirem) lifetime dose causes an estimated 0.0005 chance of incurring a fatal cancer.

In a population of 10,000 people, national statistics indicate that about 2,224 people would die from cancer of one form or another. Using information developed by the International Commission on Radiological Protection, if all 10,000 people received a dose of 200 millirem during their lifetimes (in addition to the normal background radiation dose), an estimated 1 additional cancer fatality would occur in that population. However, we would not be able to tell which of the 2,225 fatal cancers was caused by radiation and, possibly, the additional radiation would cause no fatal cancers.

Sometimes, calculations of the number of latent cancer fatalities associated with radiation exposure do not yield whole numbers, and, especially in environmental applications, may yield numbers less than 1.0. For example, if each individual in a population of 100,000 received a total dose of 0.001 rem, the collective dose would be 100 person-rem and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons $\times$ 0.001 rem $\times$ 0.0005 latent cancer fatality per person-rem). How should one interpret a nonintegral number of latent cancer fatalities, such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. For most groups, no one would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 latent fatal cancer would result; in exceptionally few groups, 2 or more latent fatal cancers would occur. The *average* number of deaths over all of the groups would be 0.05 latent fatal cancer (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome for any single group is 0 latent cancer fatalities.

latent cancer fatalities that could occur in the repository workforce from the radiation dose received over the entire project would be about 4.0 for the higher-temperature repository operating mode. For the lower-temperature operating mode, the number of latent cancer fatalities would range from 4.4 to 6.8 for the project duration, depending on the length of time before closure.

About 70 percent of the radiological impacts to workers for the Proposed Action would occur during the operations period. The principal contributor to these operations impacts would be surface facility operations, which would involve receipt, handling, and packaging of spent nuclear fuel and high-level radioactive waste for emplacement. The second largest contributor to worker impacts would be subsurface monitoring, which would increase proportionately with the length of time monitoring would be carried out.

Preclosure Radiological Impacts to the Public. Short-term radiological health impacts to the public for Yucca Mountain construction, operation and monitoring, and closure would be small. (Impacts from transportation are discussed in Section S.4.2.) More than 99.9 percent of the potential health impact would be from naturally occurring radon-222 and its decay products released in exhaust ventilation air. The highest annual dose would range from 0.73 to 1.3 millirem, less than 1 percent of the annual 200-millirem dose that members of the public in Amargosa Valley would receive from ambient levels of naturally occurring radon-222 and its decay products.

The maximally exposed individual would have an increase in the probability of incurring a latent cancer fatality ranging from about 0.000016 to 0.000031 (from 16 to 31 chances in 1,000,000) from exposure to radionuclides released from repository facilities over a 70-year lifetime. The total estimated number of

latent cancer fatalities in the potentially exposed population would range from 0.46 for the higher-temperature operating mode to 0.97 to 2.0 for the lower-temperature repository operating mode.

For the sake of comparison, statistics published by the Centers for Disease Control indicate that, during 1998, 24 percent of all deaths in the State of Nevada were attributable to cancer of some type and cause. Assuming this mortality rate would remain unchanged for the estimated population in 2035 of about 76,000 within 80 kilometers (50 miles) of the Yucca Mountain site, about 18,000 members of this population would be likely to die from cancer-related causes unrelated to the Proposed Action. During the time the project was active (100 to 324 years), the number of cancer deaths unrelated to the project would range from 30,000 to 89,000 in the general population. Estimated project-related impacts (0.46 to 2.0) would be a very small increase (0.007 percent or less) over this baseline.

Long-Term Radiological Health Impacts. DOE considered potential long-term human health impacts for 10,000 years from the start of emplacement. The analysis estimated potential human health impacts due to processes and events such as corrosion of waste packages, dissolution of waste forms, seismic events, and changing climate. In addition, it considered the effects of such disturbances as exploratory drilling or volcanic events.

UNCERTAINTY IN LONG-TERM PERFORMANCE

Uncertainty is associated with estimates of long-term repository performance. The uncertainty regarding a repository's long-term performance was handled in two ways. First, where the uncertainty was considered very important to the outcome, conservative assumptions were used that tended to overstate the risks that would be obtained by a more realistic model. Second, ranges of data were used in a probabilistic sampling routine to produce ranges of results that reflected the effect of the range of inputs.

The heat generated by spent nuclear fuel and high-level radioactive waste could affect both the short-term (before repository closure) and the long-term performance of the repository (that is, the ability of the engineered and natural barrier system to isolate the emplaced waste from the accessible environment for long periods). The temperature of the repository after emplacement of spent nuclear fuel and high-level radioactive waste could have a direct effect on the corrosion rate and integrity of the waste packages. Further, the repository temperature could affect the geochemistry, hydrology, and mechanical stability of the emplacement drifts, which in turn could influence groundwater flow and the transport of radionuclides from the engineered and natural barrier systems to the environment.

For the range of repository operating modes, radioactive materials that entered the groundwater would produce the primary impacts from the repository to human health in the far future. Figure S-22 shows the potential movement of contaminants from the repository to the accessible environment. The analysis estimated human health impacts from the groundwater pathway at three locations in the Yucca Mountain region: water wells approximately 18 and 30 kilometers (11 and 19 miles) from the repository and the nearest surface-water discharge point, which is about 60 kilometers (37 miles) away. The estimated health impact is expressed as the probability of a resulting latent cancer fatality from lifetime use of the contaminated water.

Under the entire range of repository operating modes, less than 1 latent cancer fatality would be likely over the 10,000-year analysis period. The analysis indicated that the higher-temperature operating mode would have a low, but nonetheless higher, annual dose [0.00002 millirem at 18 kilometers (11 miles)] and correspondingly greater health effects on the reasonably maximally exposed individual (lifetime probability of a latent fatal cancer of 6×10^{-10}) than the range of lower-temperature modes. In addition, concentrations of chemically toxic materials were found to be lower than identified Maximum

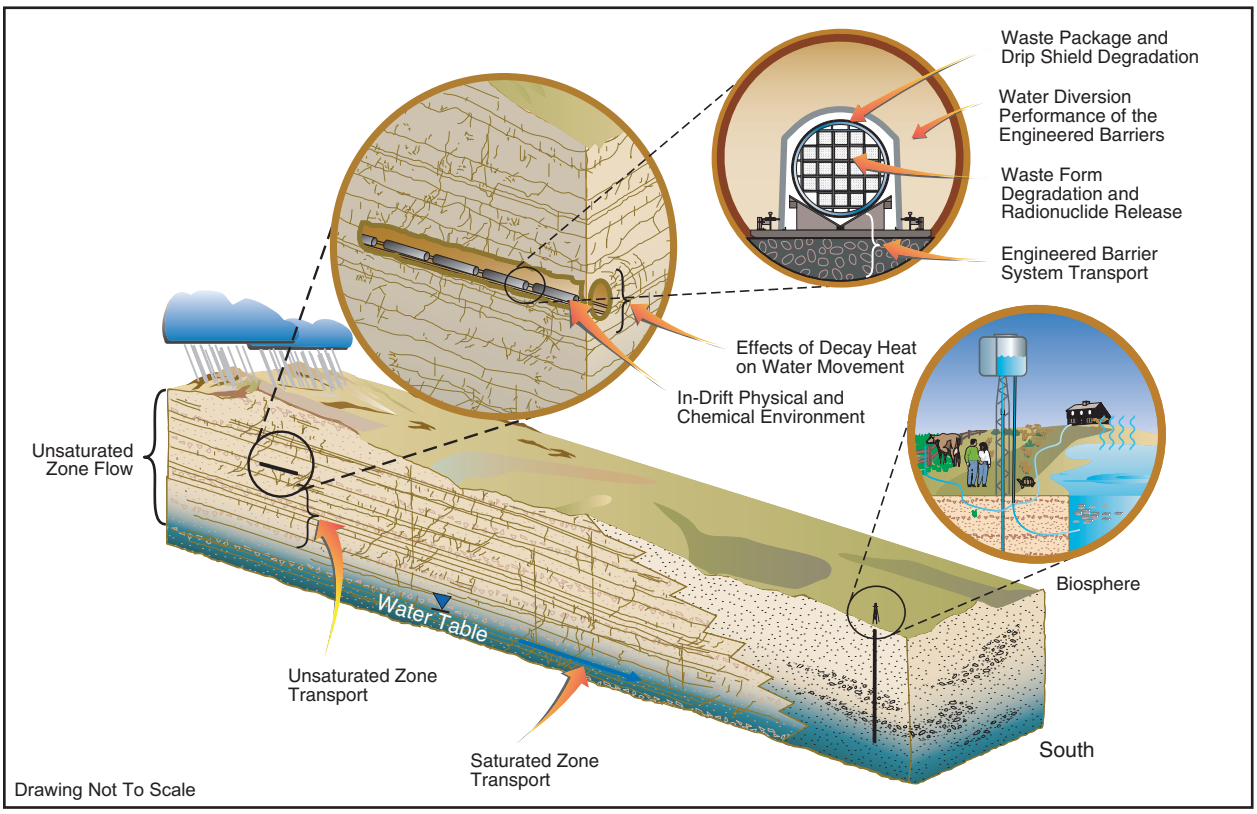


Figure S-22. Schematic illustration of the processes modeled for Total System Performance Assessment.

Contaminant Level Goals. Where no levels or goals have been established were found to be very low. Therefore, DOE does not anticipate detrimental impacts to water quality or human health from toxic materials.

In addition, DOE estimated the annual dose for 1 million years after repository closure. For the higher-temperature repository operating mode, the peak annual dose would be 150 millirem to a reasonably maximally exposed individual approximately 18 kilometers (11 miles) from the repository, occurring 480,000 years after closure (120 millirem under the lower-temperature operating mode). Variations in the peak annual dose to a reasonably maximally exposed individual among the range of operating modes would be caused by earlier waste package failures under the higher-temperature operating mode, placement of waste packages in different areas of the repository, and different amounts of water infiltrating through the different repository areas.

The analysis of a drilling intrusion event occurring at 30,000 years indicated a peak of the mean annual dose to the reasonably maximally exposed individual approximately 18 kilometers (11 miles) downstream of the repository would be 0.002 millirem, occurring a short time after 100,000 years. The analysis of an igneous activity scenario, including a volcanic eruption event and igneous intrusion event indicated a peak of the mean annual dose to the reasonably maximally exposed individual approximately 18 kilometers downstream of the repository would be 0.1 millirem.

Congress, in the Energy Policy Act of 1992, directed the Environmental Protection Agency to develop public health and safety standards for the protection of the public from releases of radioactive materials stored or disposed of in a repository at the Yucca Mountain site. Congress also directed the Nuclear Regulatory Commission to publish criteria for licensing a repository that would be consistent with the radiation protection standards established by the Environmental Protection Agency. In part, the

Environmental Protection Agency standards (40 CFR Part 197) and Nuclear Regulatory Commission criteria (10 CFR Part 63) prescribe radiation exposure limits that the repository, based on a performance assessment, cannot exceed during a 10,000-year period after closure.

In the EIS, DOE has evaluated the environmental impacts of a natural and engineered barrier system designed to isolate radioactive materials from the environment for thousands of years. As a result of this evaluation, DOE would not expect the repository to result in impacts to public health beyond those that could result from the prescribed radiation exposure and activity concentration limits during the 10,000-year period after closure.

S.5.1.9 Accident Scenarios

ACCIDENT

An unplanned event or sequence of events that results in undesirable consequences.

The evaluation of accident scenarios associated with the Proposed Action included the potential for radiological accidents and accidents involving exposure to hazardous and toxic substances before repository closure. The potentially affected individuals considered include (1) the maximally exposed individual, a hypothetical member of the public at the point on the site boundary who would receive the largest dose, (2) the involved worker who would be handling the spent nuclear fuel or high-level radioactive waste when the accident occurred, (3) the noninvolved worker near the accident but not involved in handling the material, and (4) members of the public living within about 80 kilometers (50 miles) of the repository. The accident scenario analysis examined consequences under both median (50th-percentile) meteorological conditions and highly unfavorable meteorological conditions (95th-percentile, or those that would not be exceeded more than 5 percent of the time) that tend to maximize potential radiological impacts.

Initiators of radiological accident scenarios could be external or internal. External initiators originate outside a facility and affect its ability to confine radioactive material. They include human-caused events such as aircraft crashes, external fires and explosions, and natural phenomena such as seismic disturbances and extreme weather conditions. Internal initiators occur inside a facility and include human errors, equipment failures, or combinations of the two. DOE analyzed initiating events applicable to repository operations to define subsequent sequences of events that could result in releases of radioactive material or radiation exposure. For each event in these accident sequences, the analysis estimated and combined probabilities to produce an estimate of the overall accident probability for the sequence. In addition, the analysis used bounding (maximum reasonably foreseeable) accident scenarios to represent the impacts from groups of similar accidents. Finally, it evaluated the consequences of the postulated accident scenarios by estimating the potential radiation dose and radiological impacts.

The radionuclide source term for various accident scenarios could involve several different types of radioactive materials. These would include commercial spent nuclear fuel from both boiling- and pressurized-water commercial reactors, DOE spent nuclear fuel, high-level radioactive waste incorporated in a glass matrix, and weapons-grade plutonium either immobilized in a high-level radioactive waste glass matrix or as mixed-oxide fuel. In addition, the analysis examined accident scenarios involving the release of low-level waste generated and handled at the repository, primarily in the Waste Treatment Building.

In a change from the analysis in the Draft EIS, DOE used a “representative fuel assembly” for all accident analyses for the repository. The Draft EIS used average fuel assemblies that were aged approximately 26 years out of the reactor. Based on a relative hazard index, the representative fuel assemblies analyzed in the Final EIS are only about 14 years out of the reactor and have a higher burnup, meaning they contain a higher concentration of radionuclides than those used in the Draft EIS analyses, and therefore result in more conservative impact estimates than those presented in the Draft EIS.

After a screening to determine the internal and external initiators that would be applicable to the repository and that are considered reasonably foreseeable, 10 accident scenarios were analyzed in detail. These accidents include both low-probability/high-consequence events and high-probability/low-consequence events. These scenarios bound the risks of credible accidents at the repository. They include accidents in the Cask Handling Area, the Canister Transfer System, the Assembly Transfer System, the Disposal Container Handling Area, the Surface Aging Facility, and the Waste Treatment Building. The scenarios consider drops and collisions involving shipping casks, bare fuel assemblies, low-level radioactive waste drums, and the waste package transporter. The maximum reasonably foreseeable accident (a credible accident scenario with the highest foreseeable consequences) was determined to be a beyond-design-basis seismic event. For this accident, using unfavorable weather conditions, the impacts to the maximally exposed offsite individual would be 38 millirem and would result in an estimated 0.011 additional latent cancer fatality for the population within 80 kilometers (50 miles) of the repository.

Impacts to the noninvolved worker from the reasonably foreseeable accidents would result in a maximum dose of 25 rem during the beyond-design-basis seismic event. This maximum dose would correspond to a 1-percent chance of incurring a latent cancer fatality. Severe accidents would be likely to result in the deaths of some involved workers.

DOE evaluated the likelihood of an accidental crash of aircraft (military and commercial) into the surface aging facility. The analysis determined that the aircraft would not penetrate the storage modules and a release of radioactive materials would not occur.

In response to public comments and to provide further information about accident risks, DOE analyzed an accident scenario in which a large commercial jet aircraft would crash into the repository facilities. The probability of this accident is less likely than the threshold considered reasonably foreseeable (1 in 10 million). However, if the accident occurred, the estimated consequences would include a dose of 4.5 rem to the maximally exposed offsite individual and a corresponding likelihood of 0.0023 that this individual would incur a fatal cancer. The consequences to the population for this event would be 78 person-rem and an estimated 0.039 latent cancer fatality. In addition, passengers on board the aircraft and any workers in the vicinity of the crash could perish.

A release of hazardous or toxic (nonradiological) materials during accidents involving spent nuclear fuel or high-level radioactive waste at the repository, however, would be very unlikely. The repository would not accept hazardous waste, although some potentially hazardous metals such as arsenic or mercury could be present in the high-level radioactive waste. Because such waste would be contained in a glass or ceramic matrix, exposure of workers or members of the public from any accident would be highly unlikely. In any event, because of the large quantity of radioactive material, radiological considerations would outweigh nonradiological concerns under most accident conditions.

S.5.1.10 Noise and Vibration

Background noise at Yucca Mountain is caused by natural phenomena such as rain and wind and noise from people, including vehicles from site characterization activities and from occasional low-flying military jets. Sound-level measurements recorded in May 1997 at areas adjacent to and at the Yucca Mountain site were consistent with noise levels associated with industrial operations (sound levels from 44 to 72 decibels). Background levels of ground vibration at Yucca Mountain are also low. Other than site characterization activities, there is a lack of sources of ground vibration impacts (pile-driving, heavy earthmoving equipment, blasting).

Repository activities during construction, operation, and closure that could generate elevated noise levels would include use of heavy equipment, ventilation fans, diesel generators, transformers, and a concrete batch plant.

Workers at the repository site could be exposed to elevated levels of noise. However, worker exposures to elevated noise levels during all repository phases would be controlled by the use of protective equipment, so impacts from noise would be unlikely.

The distance from the Yucca Mountain site to the nearest housing is about 22 kilometers (14 miles). Based on an estimated maximum noise level from repository operations, DOE calculated that noise from the repository would be at the lower limit of human hearing at 6 kilometers (3.7 miles). For this reason, DOE expects that noise impacts to the public from repository construction and operations would be small.

S.5.1.11 Aesthetics

Yucca Mountain has visual characteristics fairly common to the region, and the visibility of the site from publicly accessible locations is low or nonexistent. The intervening Striped Hills and the low elevation of the southern end of Yucca Mountain and Busted Butte would obscure the view of repository facilities from the south near the Town of Amargosa Valley, approximately 22 kilometers (14 miles) away. There is no public access to the north or east of the repository site to enable viewing of the facilities. The only structures that could potentially be visible from the west that exceed the elevation of the southern ridge of Yucca Mountain [1,500 meters (4,900 feet)] would be the exhaust ventilation stacks and support structures that would be constructed along the crest of the mountain.

DOE would provide lighting for operation areas at the repository that could be visible from public access points. However, there would not be significant visual impacts due to repository lighting to users of Death Valley National Park. The Towns of Amargosa Valley, Beatty, and Pahrump, located between the park and the proposed repository, would probably cause greater impacts to the nightly viewshed than operational lighting at the repository site. The visual impact of the lighting from Las Vegas would also be more significant in the region than that of the repository. The use of shielded or directional lighting at the repository would limit the amount of light that could be seen from outside the repository area. Closure activities, such as dismantling facilities and reclaiming the site, would restore the visual quality of the landscape, as viewed from the site itself.

S.5.1.12 Utilities, Energy, Materials, and Site Services

The scope of the analysis included electric power use, fossil-fuel consumption, consumption of construction materials, and onsite services such as emergency medical support, fire protection, and security and law enforcement. Overall, DOE does not expect large impacts to residential water, energy, materials, and emergency services from the Proposed Action.

Electricity. The repository demand for electricity would be well within the expected regional capacity for power generation. The current electric power supply line has a capacity of 10 megawatts. During the early stages of repository operations, when emplacement activities would be occurring while new drifts were being developed, the peak electric power demand would be between 40 and 54 megawatts, depending on the operating mode. Therefore, DOE would need to enhance the electric power delivery system to the Yucca Mountain site. The solar power generating facility, which could produce as much as 3 megawatts of power, would be a dual-purpose facility, serving as a demonstration of photovoltaic power generation and augmenting the overall repository electric power supply (as much as 7 percent).

Fossil Fuel. Fossil fuel would include diesel fuel, gasoline, and fuel oil. Yearly repository use during construction would be less than 1 percent of the current use in Clark, Lincoln, and Nye Counties, and should result in only small impacts to fossil-fuel supplies.

Fossil-fuel use during the operation and monitoring phase would be highest during emplacement and development operations and would decrease substantially during monitoring and maintenance activities.

The highest annual use would be less than 5 percent of the 1996 use in Clark, Lincoln, and Nye Counties. Thus, the projected use of liquid fossil fuels should be within the available regional capacity and should result in only small impacts to fossil-fuel supplies. Hydraulic oils and lubricants and nonfuel hydrocarbons would be used to support equipment operation. These materials would be recycled and reused.

Construction Materials. The primary materials needed to build the repository would be concrete, steel, and copper. Concrete, which consists of cement and aggregate, would be used for tunnel liners in main drifts and ventilation shafts and the construction of surface facilities. DOE would use regionally available aggregate for concrete, and would purchase cement regionally. The lower-temperature repository operating mode would require the largest amount of concrete (up to 1.4 million cubic meters or 1.8 million cubic yards), which would be less than about 3 percent of the amount used in Nevada in 1998. Because steel and copper have worldwide markets, DOE expects little or no impact from an increased demand for steel and copper in the region.

Site Services. An emergency response system would be established to respond to accidents at the repository site. The capabilities would include emergency and rescue equipment, communications, facilities, and trained professionals to respond to fire, radiological, mining, industrial, and general accidents above or below ground. The onsite service capabilities would be able to respond to most events, including underground events, without outside support. Therefore, a large impact on the emergency services of surrounding communities or counties would be unlikely.

S.5.1.13 Waste Management

The evaluation of waste management impacts considered the quantities of nonhazardous industrial, sanitary, hazardous, and radioactive wastes that repository-related activities would generate. DOE would build onsite facilities to accommodate construction and demolition debris, sanitary and industrial solid wastes, sanitary sewage, and industrial wastewater, or could use a landfill at the Nevada Test Site. DOE would use less than 4 percent of the existing available offsite capacity for low-level radioactive waste disposal at the Nevada Test Site and a smaller fraction of the available hazardous waste disposal capacity.

S.5.1.14 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to work to achieve "environmental justice" by identifying and addressing the potential for their activities to cause disproportionately high and adverse impacts to minority and low-income populations. As part of this process, DOE has identified the minority and low-income communities in Clark, Lincoln, and Nye Counties, using U.S. Bureau of the Census population designations to determine areas with high concentrations of minority or low-income populations.

DOE considered the potential for disproportionately high and adverse impacts to minority and low-income populations under both normal and accident conditions using the identified potential impacts to the general population and an assessment of potential unique pathways, sensitivities, or cultural practices that could

POPULATIONS

Minority: individuals who are American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. For this EIS, a minority community is one in which the percent of the population of a racial or ethnic minority is 10 percentage points higher than the percent found in the population as a whole.

Low income: individuals with an income below the poverty level defined by the U.S. Bureau of the Census. A low-income population is one in which 20 percent or more of the persons in the population live in poverty.

result in high and adverse impacts on minority and low-income populations. The EIS analyses determined that the impacts that could occur to public health and safety would be small for the population as a whole for all phases of the Proposed Action, and that no subsections of the population, including minority or low-income populations, would receive disproportionately high and adverse impacts. The Department recognizes, however, that Native American tribes in the region consider the intrusive nature of the repository and continuation of restrictions on access to lands where the repository would be located to have an adverse impact on all elements of the natural and physical environment and to their way of living within that environment.

S.5.1.15 Sabotage

In the aftermath of the tragic events of September 11, DOE is continuing to assess measures that it could take to minimize the risk or potential consequences of radiological sabotage or terrorist attacks against our Nation's proposed monitored geologic repository.

Over the long term (after closure), deep geologic disposal of spent nuclear fuel and high-level radioactive waste would provide optimal security by emplacing the material in a geologic formation that would provide protection from inadvertent and advertent human intrusion, including potential terrorist activities. The use of robust metal waste packages to contain the spent nuclear fuel and high-level radioactive waste more than 200 meters (660 feet) below the surface would offer significant impediments to any attempt to retrieve or otherwise disturb the emplaced materials.

In the short term (prior to closure), the proposed repository at Yucca Mountain would offer certain unique features from a safeguards perspective: a remote location, restricted access afforded by Federal land ownership and proximity to the Nevada Test Site, restricted airspace above the site, and access to a highly effective rapid-response security force.

Current Nuclear Regulatory Commission regulations (10 CFR 63.21 and 10 CFR 73.51) specify a repository performance objective that provides "high assurance that activities involving spent nuclear fuel and high-level waste do not constitute an unreasonable risk to public health and safety." The regulations require that spent nuclear fuel and high-level radioactive waste be stored in a protected area such that:

- Access to the material requires passage through or penetration of two physical barriers. The outer barrier must have isolation zones on each side to facilitate observation and threat assessment, be continually monitored, and be protected by an active alarm system.
- Adequate illumination must be provided for observation and threat assessment.
- The area must be monitored by random patrol.
- Access must be controlled by a lock system, and personnel identification must be used to limit access to authorized persons.

A trained, equipped, and qualified security force is required to conduct surveillance, assessment, access control, and communications to ensure adequate response to any security threat. Liaison with a response force is required to permit timely response to unauthorized entry or activities. In addition, the Nuclear Regulatory Commission requires (10 CFR Part 63, by reference to 10 CFR Part 72) that comprehensive receipt, periodic inventory, and disposal records be kept for spent nuclear fuel and high-level radioactive waste in storage. A duplicate set of these records must be kept at a separate location.

DOE believes that the safeguards applied to the proposed repository should involve a dynamic process of enhancement to meet threats, which could change over time. Repository planning activities would

continue to identify safeguards and security measures that would further protect fixed facilities from terrorist attack and other forms of sabotage. Additional measures that DOE could adopt include:

- Facilities with thicker reinforced walls and roofs designed to mitigate the potential consequences of the impact of airborne objects
- Underground or surface bermed structures to lessen the severity of damage in cases of aircraft crashes
- Additional doors, airlocks, and other features to delay unauthorized intrusion
- Additional site perimeter barriers to provide enhanced physical protection of site facilities
- Active denial systems to disable any adversaries, thereby preventing access to the facility

Although it is not possible to predict if sabotage events would occur, and the nature of such events if they did occur, DOE examined various accident scenarios that approximate the types of consequences that could occur. These accidents and their consequences are discussed in Section S.5.1.9.

S.5.2 TRANSPORTATION

The loading and shipping of spent nuclear fuel and high-level radioactive waste would take place at 72 commercial and 5 DOE sites. Legal-weight trucks and trains would travel on the Nation's highways and railroads. Barges and heavy-haul trucks could be used for the short-distance transport of spent nuclear fuel from some commercial sites to nearby railroads. Shipments of spent nuclear fuel and high-level radioactive waste arriving in Nevada would travel to the Yucca Mountain site by legal-weight truck, rail, or heavy-haul truck. Legal-weight truck shipments would use existing highways in accordance with U.S. Department of Transportation regulations. Figures S-13 and S-14 show the alternatives for rail corridors and intermodal transfer station locations and associated heavy-haul truck routes, respectively, in the State of Nevada.

DOE analyzed the impacts of transporting these materials to the repository under the mostly legal-weight truck and mostly rail scenarios. Under the mostly legal-weight truck scenario, most of the spent nuclear fuel and high-level radioactive waste would be shipped to Nevada by legal-weight truck, while naval fuel would be shipped by rail. Under the mostly rail scenario, commercial spent nuclear fuel from most sites and DOE and naval spent nuclear fuel and high-level radioactive waste would arrive in Nevada by rail. However, commercial fuel from a few commercial sites would initially be shipped by legal-weight truck because those sites do not currently have the capability to load a rail cask.

At present, there is no rail access to the Yucca Mountain site. If material was shipped by rail, a branch line that connected an existing main line to the Yucca Mountain site would have to be built or the material would have to be transferred to heavy-haul trucks at an intermodal transfer station and transported over existing highways that might need upgrading. DOE examined the environmental impacts that would be associated with a new branch rail line (five alternative rail corridors) and with an intermodal transfer station (three alternative locations) and heavy-haul truck routes (five alternative routes).

S.5.2.1 National Transportation Impacts

National transportation includes the impacts of transporting spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site. Much of the difference in the impacts between the mostly legal-weight truck and mostly rail scenarios would result from the differing number of shipments over the 24-year transportation period and differences in the characteristics of the truck and rail modes of transport. The mostly legal-weight truck scenario would involve about

53,000 shipments (2,200 annually), and the mostly rail scenario would involve approximately 10,700 shipments (450 annually). Primarily because of the larger number of shipments, the mostly legal-weight truck scenario would have greater incident-free radiological impacts (latent cancer fatalities), even though each individual truck shipment would carry less radioactive material than a rail shipment.

The EIS analysis considered potential accidents based on the 19 truck and 21 rail accident cases presented in NUREG-6672, *Reexamination of Spent Fuel Shipment Risk Estimates.* In addition, the analysis estimated impacts of postulated releases from accidents in three population zones—urban, suburban, and rural—under a set of meteorological (weather) conditions that represent the national average meteorology. The analysis used state-specific accident data, the lengths of routes in the population zones in states through which the shipments would pass, and the number of shipments that would use the routes to determine accident probabilities.

ESTIMATED NATIONAL TRANSPORTATION IMPACTS (for 24 years of operation)

Impact	Mostly legal-weight truck scenario	Mostly rail scenario
Incident-free latent cancer fatalities		
Involved worker	12	3
Public[a]	3	1
Latent cancer fatalities from accidents		
Public	0.00023	0.00045
Traffic fatalities[b]	5	3
Latent cancer fatalities from maximum reasonably foreseeable accident	0.55	5
Frequency of occurrence per year	2.3×10^{-7}	2.8×10^{-7}

a. These latent cancer fatalities would result from very low doses to a very large population.
b. Does not include 10 to 17 fatalities that could occur from repository workers commuting and transporting construction materials to the repository.

In addition to the risk due to accidents involving a release of radioactive material, the analysis examined the impacts of loss-of-shielding accidents. The loss-of-shielding scenarios range from an accident with no loss of shielding to a low-probability severe accident involving both a loss of shielding (and any increased direct exposure) and a release of some of the contents of the cask.

The EIS analysis also estimated impacts from an unlikely but severe accident called a *maximum reasonably foreseeable accident* to provide perspective about the consequences for a population that might live nearby. For maximum reasonably foreseeable accidents, the consequences were estimated for each of the accidents and for both truck and rail casks from the spectrum of accidents presented in NUREG-6672. For each accident, the possible combinations of weather conditions, population zones, and transportation modes were considered. The accidents were then ranked according to those that would have a likelihood greater than 1 in 10 million per year and that would have the greatest consequences.

Real life transportation accidents involve collisions of many kinds, such as with other vehicles and along-the-route obstacles, involvement in fires and explosions, inundation, and burial. These accidents are caused, in turn, by a variety of initiating events including human error, mechanical failure, and natural causes such as earthquakes. Accidents occur in many different kinds of places including mountain passes and urban areas, rural freeways in open landscapes, and rail switching yards.

Thus, there are as many different kinds of unique initiating events and accident conditions as there are accidents. Analyzing each accident that could occur would not be practical. However, it is practical to analyze a limited number of accidents, each of which represents a grouping of initiating events and conditions having similar characteristics. For example, the EIS analyzes the impacts of a collection of

collision accidents in which a cask would be exposed to impact velocities in the range of 97 to 145 kilometers (60 to 90 miles) per hour. The EIS also analyzes a maximum reasonably foreseeable accident in which a collision would not occur but where the temperature of a rail cask containing spent nuclear fuel would rise to between 750°C and 1,000°C (between 1,400°F and 1,800°F). The conditions of the maximum reasonably foreseeable accident analyzed in the EIS envelop conditions reported for the Baltimore Tunnel fire (a train derailment and fire that occurred in July 2001 in a tunnel in Baltimore, Maryland). Temperatures in that fire were reported to be as high as 820°C (1,500°F), and the fire was reported to have burned for up to 5 days.

DOE also evaluated the potential consequences of an accidental crash of a large jet aircraft into a truck cask or rail cask. The analysis determined that penetration of the cask would not occur; however, potential seal failure could result in releases of radiological materials. The consequences associated with this event would be less than 1 latent cancer fatality in an urban population.

The consequences of the maximum reasonably foreseeable transportation accident (an accident with the highest consequence for human health that can be reasonably foreseen) would be higher under the mostly rail scenario (5 latent cancer fatalities) than under the mostly legal-weight truck scenario (1 latent cancer fatality) principally because the amount of material in a rail shipment would be larger than that in a legal-weight truck shipment.

The Nuclear Regulatory Commission has developed a set of rules specifically aimed at protecting the public from harm that could result from sabotage of spent nuclear fuel casks. Known as physical protection and safeguards regulations (10 CFR 73.37), these security rules are distinguished from other regulations that deal with issues of safety affecting the environment and public health. The objectives of the physical protection and safeguard regulations are to:

- Minimize the possibility of sabotage
- Facilitate recovery of spent nuclear fuel shipments that could come under control of unauthorized persons

The cask safety features that provide containment, shielding and thermal protection also provide protection against sabotage. The casks would be massive. The spent nuclear fuel in a cask would typically be only about 10 percent of the gross weight; the remaining 90 percent would be shielding and structure.

It is not possible to predict whether sabotage events would occur and, if they did, the nature of such events. Nevertheless, DOE examined various accidents, including an aircraft crash into a transportation cask. The consequences of both the maximum reasonably foreseeable accident and the aircraft crash are presented above for the mostly truck and mostly rail transportation scenarios and can provide an approximation of the type of consequences that could occur from a sabotage event. In addition, DOE analyzed the potential consequences of a saboteur using a device on a truck or rail cask. The results of this analysis indicate that the risk of the maximally exposed individual incurring a fatal cancer would increase from approximately 23 percent (the current risk of incurring a fatal cancer from all other causes) to about 29 percent. The same event could cause 48 latent cancer fatalities in an assumed population of a large urban area.

Because of the terrorist attack of September 11, 2001, the Department and other agencies are reexamining the protections built into their physical security and safeguards systems for transportation shipments. As dictated by results of this reexamination, DOE would modify its methods and systems as appropriate.

S.5.2.2 Nevada Transportation Impacts

The analysis of national transportation includes the analysis of transportation from 77 generation sites to Yucca Mountain. This includes transportation in the State of Nevada. To present a more focused description of impacts in Nevada, the EIS discusses Nevada transportation separately as well. Spent nuclear fuel and high-level radioactive waste shipped to the repository by legal-weight truck would continue in the same vehicles to the Yucca Mountain site. Material that traveled by rail would either continue to the repository on a newly constructed branch rail line or transfer to heavy-haul trucks at an intermodal transfer station that DOE would build in Nevada for shipment on existing highways that could require upgrades. Selection of a specific rail alignment within a corridor, or the specific location of an intermodal transfer station or the need to upgrade the associated heavy-haul truck routes, would require additional field surveys; environmental and engineering analysis; State, local, and Native American government consultation, and National Environmental Policy Act reviews.

Rail Corridor Implementing Alternatives. DOE assessed five rail implementing alternatives—the Caliente, Carlin, Caliente-Chalk Mountain, Jean, and Valley Modified corridors (see Figure S-13). The assessment considered the impacts of constructing a branch rail line in one of the five 400-meter (0.25-mile)-wide corridors including variations of the corridors. Each corridor would connect the Yucca Mountain site with an existing mainline railroad in Nevada.

Intermodal Transfer Station and Heavy-Haul Truck Route Implementing Alternative. DOE assessed alternative intermodal transfer station locations at rail terminals near Caliente, Apex/Dry Lake, and Sloan/Jean (see Figure S-14). The intermodal transfer station would transfer casks containing spent nuclear fuel and high-level radioactive waste from railcars to heavy-haul trucks and empty casks from heavy-haul trucks to railcars. In addition, DOE assessed three alternative heavy-haul truck routes from a Caliente intermodal transfer station—Caliente, Caliente/Chalk Mountain, and Caliente/Las Vegas—and one route each from the Apex/Dry Lake and Sloan/Jean locations. This implementing alternative probably would include an average of 110 legal-weight truck shipments of commercial spent nuclear fuel each year from the six sites that do not currently have the capability to load rail casks.

Estimated impacts for any of the five alternative rail corridors or five heavy-haul truck routes over the 24 years of transport operations would include the following:

- The incident-free collective dose to members of the public would result in less than 1 latent cancer fatality.
- The cumulative radiological accident risk would be less than 0.0002 latent cancer fatality, taking into account both the probability of accident occurrence and the resulting consequences if an accident were to occur.
- The likelihood of the maximum reasonably foreseeable accident in an urbanized area nationally is about 2.3 to 2.8 chances in 10 million per year; if such an accident were to occur, from 1 to 5 latent cancer fatalities could result.
- From 1 to 5 fatalities would be likely to occur due to traffic accidents.
- The amount of land disturbed (for an intermodal transfer station and mid-route stops) would be small, generally less than 0.3 square kilometer (75 acres).

RAIL CORRIDOR IMPACTS

Caliente

- 513 kilometers (319 miles) long, requiring about 10 hours to complete a one-way trip.
- Would disturb 18 square kilometers (4,500 acres) of land.
- 842 new jobs (direct and indirect) could be created during 46 months of construction.
- Estimated life-cycle cost is $880 million (2001 dollars).
- Other: One potential alignment would pass through Timbisha Shoshone Trust Lands.

Carlin

- 520 kilometers (323 miles) long, requiring about 9 hours to complete a one-way trip.
- Would disturb 19 square kilometers (4,900 acres) of land.
- 783 new jobs (direct and indirect) could be created during 46 months of construction.
- Estimated life-cycle cost is $821 million (2001 dollars).
- Other: One potential alignment would pass through Timbisha Shoshone Trust Lands.

Caliente-Chalk Mountain

- 345 kilometers (214 miles) long, requiring about 8 hours to complete a one-way trip.
- Would disturb 13 square kilometers (3,000 acres) of land.
- 647 new jobs (primary and secondary) could be created during 43 months of construction.
- Estimated life-cycle cost is $622 million (2001 dollars).
- Nonpreferred alternative: Strongly opposed by the U.S. Air Force because of the adverse effect on security and operations at Nellis Air Force Range.

Jean

- 181 kilometers (114 miles) long, requiring about 4 hours to complete a one-way trip.
- Would disturb 9 square kilometers (2,000 acres) of land.
- 526 new jobs (direct and indirect) could be created during 43 months of construction.
- Estimated life-cycle cost is $462 million (2001 dollars).
- Other: Could affect scenic quality lands and habitat for desert tortoise; would pass near the Las Vegas metropolitan area.

Valley Modified

- 159 kilometers (98 miles) long, requiring about 3 hours to complete a one-way trip.
- Would disturb 5 square kilometers (1,240 acres) of land.
- 245 new jobs (direct and indirect) could be created during 40 months of construction.
- Estimated life-cycle cost is $283 million (2001 dollars).
- Other: Could affect Desert National Wildlife Range on Nellis Air Force Range, would pass near Las Vegas Paiute Indian Reservation; would pass near the Las Vegas metropolitan area.

- Impacts to biological resources due to habitat disturbance and loss of individuals of affected species would be small. In particular, the activities associated with constructing a branch line, building an intermodal transfer station, or upgrading and maintaining a heavy-haul truck route to Yucca Mountain would be likely to adversely affect a few individual desert tortoises; these activities would not negatively affect regional populations of desert tortoises, jeopardize the continued existence of the species, or result in adverse modification of designated critical habitat.

- Based on an assessment, potential impacts from activities in floodplains and wetlands would be small.

HEAVY-HAUL TRUCK ROUTE IMPACTS

Caliente
- 533 kilometers (331 miles) long, requiring 2 days to complete a one-way trip.
- 856 new jobs (direct and indirect) could be created during 35 months of construction.
- Estimated life-cycle cost is $669 million (2001 dollars).
- Other: Could have visual impacts to Kershaw-Ryan State Park; would pass adjacent to Timbisha Shoshone Trust Lands.

Caliente/Chalk Mountain
- 282 kilometers (175 miles) long, requiring 2 days to complete a one-way trip.
- 751 new jobs (primary and secondary) could be created during 26 months of construction (levels of employment reflect assumption of $463-million estimate to complete the northern portion of the Las Vegas Beltway).
- Estimated life-cycle cost is $548 million (2001 dollars).
- Nonpreferred alternative: Strongly opposed by the U.S. Air Force because of the adverse effect on security and operations at the Nellis Air Force Range.
- Could have visual impacts to Kershaw-Ryan State Park.

Caliente/Las Vegas
- 377 kilometers (234 miles) long, requiring 2 days to complete a one-way trip.
- 1,979 new jobs (direct and indirect) could be created during 46 months of construction.
- Estimated life-cycle cost is $607 million (2001 dollars).
- Other: Could have visual impacts to Kershaw-Ryan State Park and would pass near the Las Vegas metropolitan area; would pass near the Moapa Indian Reservation and through the Las Vegas Paiute Indian Reservation.

Sloan/Jean
- 188 kilometers (118 miles) long, requiring one-half day to complete a one-way trip.
- 3,047 new jobs (direct and indirect) could be created during 48 months of construction (levels of employment reflect assumption of $790 million estimate to complete the Southern and Western portions of the Las Vegas Beltway).
- Estimated life-cycle cost is $444 million (2001 dollars).
- Other: Would pass near the Las Vegas metropolitan area; would pass through the Las Vegas Paiute Indian Reservation.

Apex/Dry Lake
- 183 kilometers (114 miles) long, requiring one-half day to complete a one-way trip.
- 1,882 new jobs (direct and indirect) could be created during 28 months of construction (levels of employment reflect assumption of $790-million estimate to complete the northern portion of the Las Vegas Beltway).
- Estimated life-cycle cost is $387 million (2001 dollars).
- Other: Would pass near the Las Vegas metropolitan area; could pass near the Moapa Indian Reservation and through the Las Vegas Paiute Indian Reservation.

- There could be visual impacts from the existence of the branch rail line, access road, and borrow pits in the landscape and the passage of trains to and from the repository along any rail corridor.

- There would be no effect on the general availability of gasoline, diesel fuel, steel, or concrete.

- There would be no disproportionately high and adverse impacts to minority and low-income populations. DOE considered impacts that would be associated with potential routes for rail and legal-weight and heavy-haul trucks that would pass through or near the Moapa and Las Vegas Paiute Indian Reservations and the newly established Timbisha Shoshone Trust Lands.

The factors that differ among the alternative transportation corridors and routes are length and associated time of travel, land use or disturbance, industrial safety impacts, job creation, and cost. The U.S. Air Force has informed DOE that it strongly opposes the Caliente-Chalk Mountain Corridor because it could adversely affect national security-related activities of the Nellis Air Force Range (now called the Nevada Test and Training Range). The State of Nevada and the City of Las Vegas have expressed specific concerns about shipments through or near the Las Vegas metropolitan area, which would occur if either the Jean or Valley Modified Corridor or the Caliente-Las Vegas, Apex/Dry Lake, or Sloan/Jean heavy-haul truck route was selected.

S.6 Environmental Consequences of the No-Action Alternative

Under the No-Action Alternative, DOE would terminate site characterization activities at the Yucca Mountain site. Long-term storage of spent nuclear fuel and high-level radioactive waste would continue at 77 sites.

DOE analyzed the potential impacts of two no-action scenarios: long-term storage with institutional controls (Scenario 1) and long-term storage with no effective institutional control after about 100 years (Scenario 2). The Department recognizes that neither of these scenarios is likely to occur if there is a decision not to develop a repository at Yucca Mountain, but any other scenarios would be too speculative for meaningful analysis. DOE therefore chose to include the two scenarios because they provide a basis for comparison to the impacts from the Proposed Action.

Activities at the Yucca Mountain site would be the same under either Scenario 1 or 2, as would impacts at the commercial and DOE sites during the first 100 years. After about 100 years and for as long as the 10,000-year analysis period and beyond, Scenario 2 assumes that the storage facilities at the 72 commercial sites and 5 DOE sites would deteriorate and that the radioactive materials in the spent nuclear fuel and high-level radioactive waste would eventually escape to the environment, contaminating the atmosphere, soil, surface water, and groundwater.

S.6.1 RECLAMATION AND DECOMMISSIONING AT THE YUCCA MOUNTAIN SITE

Under the No-Action Alternative, DOE would end characterization and construction activities at the Yucca Mountain Repository site and would complete site decommissioning and reclamation. Land ownership and control would revert to the original controlling authority. Adverse impacts to any resource would be unlikely as a result of these activities.

The overall impact of the No-Action Alternative would be the loss of approximately 4,700 jobs in the Yucca Mountain region of influence, out of approximately 840,000 jobs in the region. Most of the lost jobs would be in disciplines (construction, engineering, administration, support, etc.) that are not unique or unusual and are similar to those in the region. However, some of the jobs would be in unique disciplines (nuclear engineering, nuclear safety, etc.) that might not otherwise be needed in the region. Fatalities from industrial hazards would be unlikely, as would latent cancer fatalities from worker or public exposure to naturally occurring radionuclides released by decommissioning and reclamation activities. Resources important to Native American interests would be preserved, although the integrity of archeological sites and resources could be threatened by increased public access if roads were open and site boundaries were not secure.